Effect of fuel additives on performance and emission characteristics of diesel engine fueled with custard apple biodiesel

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Abstract- **Biodiesel is an alternative fuel, which can replace diesel. Nowadays fossil fuels are creating a lot of pollution to the environment, so to minimize the causes and effects of diesel we can use biodiesel which can reduce pollution when compared to diesel. By using this biodiesel, we can perform the same operations that can be performed by the diesel since as per the literature survey the properties of the biodiesel are very similar to the diesel. Biodiesel can be prepared from animal fats and plant wastes. In this project, we are going to prepare biodiesel from custard seeds oil. Initially, oil is extracted from the seeds, to reduce the viscosity of oil, the transesterification process for oil is performed using methanol and KOH as catalysts to get ethyl ester and glycerol where glycerol is removed to form pure biodiesel. This biodiesel is blended with diesel in the B10(10%), B20(20%), B30(30%), proportions based on the diesel volume. Further fuel additives like Diethyl ether (DEE), and 1-butanol are added in at 5% and 10% to improve the ignition process. Performance, emission, tests are performed and the suggest results compared with the diesel to the better blend bio-diesel.**

Keywords: **Biodiesel, Custard apple seeds, Transesterification, KOH, Methanol, Diethyl ether (DEE), 1-Butanol.**

1. INTRODUCTION

Fossil fuels has dominated transportation sector since the invention of internal combustion (IC)engines in early nineteenth century. We all know the fuels like petrol, diesel are non renewable energy sources since they are depleting day by day more over they create a lot of environmental problems by releasing of lot of harm full gases like Nox, CO2 etc. To minimize these problems we can use the Biodiesel since Biodiesel has emerged as a strong diesel alternative. A large number of scientific studies have reported successful operation of CI engines with biodiesels derived from different feedstock. Biodiesel can either be used as a full replacement of minerals diesel or it can also be blended with mineral diesel in any proportion, Bio-diesel is essentially Sulphur free and engines fuelled with biodiesel emit significantly fewer particulates, hydrocarbons, and less carbon monoxide than those operating on conventional diesel fuel.

Biodiesel is a renewable, clean-burning fuel that is made from vegetable oils, animal fats, or recycled cooking oils. It is an alternative to petroleum-based diesel fuel that can be used in most diesel engines without any modifications. Biodiesel is produced through a chemical process called transesterification, which involves reacting the vegetable oil or animal fat with an alcohol, typically methanol or ethanol, and a catalyst, such as sodium hydroxide or potassium hydroxide.

Biodiesel has several advantages over traditional diesel fuel. It is a renewable and sustainable source of energy that can be produced domestically, reducing dependence on foreign oil. It is also cleaner burning than diesel fuel, emitting less carbon monoxide, particulate matter, and other harmful pollutants. In addition, biodiesel has a higher lubricity than diesel fuel, which can reduce engine wear and prolong the life of diesel engines.

Biodiesel can be used in a variety of applications, including transportation, heating, and electricity generation. It is often blended with petroleum diesel fuel to create biodiesel blends, such as B20 (20% biodiesel, 80% diesel) or B100 (100% biodiesel). Biodiesel blends can be used in diesel engines with little to no modifications.

2. REVIEW OF LITERATURE

V. Dhana Raju and P.S. Kishore et.al [1].Their experimental investigation focused on tamarind seed methyl ester (TSME) biodiesel blend with addition of Dimethyl carbonate (DMC) and 1-Pentanol as oxygenated fuel additives to investigate the performance, combustion , and emission characteristics .Tests were conducted on single cylinder diesel engine operating at varying load conditions for the fuels of Diesel , TSME20 and TSME20 with DMC and 1-Pentanol fuel additives are mainly used to improve the biodiesel properties up to a considerable extent due to its more stable , low viscosity , higher ignition rate , and rich inherent oxygen concentration produces the clean combustion of fuels in the combustion chamber

Roy et al. [2] Studied the performance and emissions of a diesel engine that fueled with biodiesel-diesel, biodiesel-diesel –additive and kerosenebiodiesel blends. This research was used to investigate the performance and emissions of various biodiesel mixes in a DI diesel engine. BSFC increased as the amount of biodiesel in the blends of biodiesel-diesel, biodiesel-diesel-additives incremented, according to the results of their tests.

Kumar et al.[3] Investigated on diesel engine using biodiesel for improving the performance and emission characteristics. They concluded that decreased in power and brake thermal efficiency and increase in fuel consumption. In most cases hydrocarbons, PM and CO emissions were found to significantly decreased with biodiesel. The reasons for such fluctuating results analyzed for further improvement in utilization of biodiesel for commercial purpose.

Prabhu et al.[4] investigated the impact of Al2O3 nano additions on the performance and emission characteristics of methyl esters in a vertical single-cylinder direct injection CI engine. In this experiment, nano additives were added to biodiesel made from jatropha and pongamia. Decreases in CO and NOx emissions, as well as increases in BTE and BSFC, were obtained as a result of the research.

Ramakrishna et al. [5] conducted a test on a diesel engine that ran on diesel maize seed oil and recirculates exhaust gas. Exhaust gas recirculation is used in this experiment to investigate NOx emission controls. The performance of the diesel engine is measured using varied ratios of corn seed oil and ECR. The application yielded good results in terms of NOx emission control.

Custard oil

Custard apple oil is an oil extracted from the seeds of the custard apple fruit (Annona squamosa). The custard apple is a tropical fruit native to Central and South America, but now widely cultivated in other parts of the world, including Asia and Africa.

Custard apple oil is rich in fatty acids, particularly oleic acid, linoleic acid, and palmitic acid. It also contains antioxidants and vitamins, such as vitamin E. The oil is commonly used in traditional medicine to treat skin conditions and is believed to have anti-inflammatory and antimicrobial properties.

In cosmetic applications, custard apple oil is often used in skincare products for its moisturizing and nourishing properties. It is also used in hair care products to condition and strengthen hair. However, more research is needed to fully understand the potential benefits and uses of custard apple oil

Ethanol

Ethanol is sometimes called "grain alcohol," is generally made in the United States from corn. It can also be made from biomass (organic materials) that include agricultural crops and waste (like rice straw), plant materials left from logging and trash that includes paper. Brazil is the largest producer in the world of ethanol and produces it from sugar cane. The alcohol found in alcoholic beverages is also considered ethanol. However, the ethanol that is used for fuel is denatured, which means additives are added to prevent human consumption.

3. METHODOLOGY

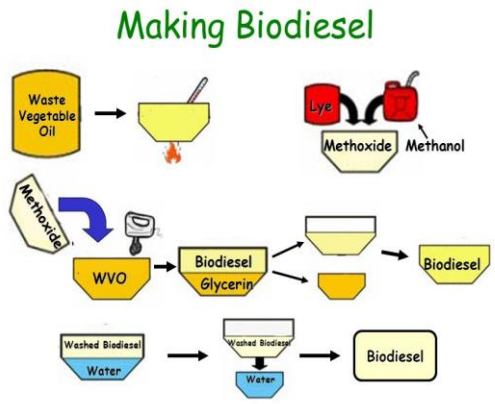
3.1 Seed Preparation:

The seeds are first cleaned and dried to remove any impurities or moisture. The seeds are then ground into

a fine powder or flakes.

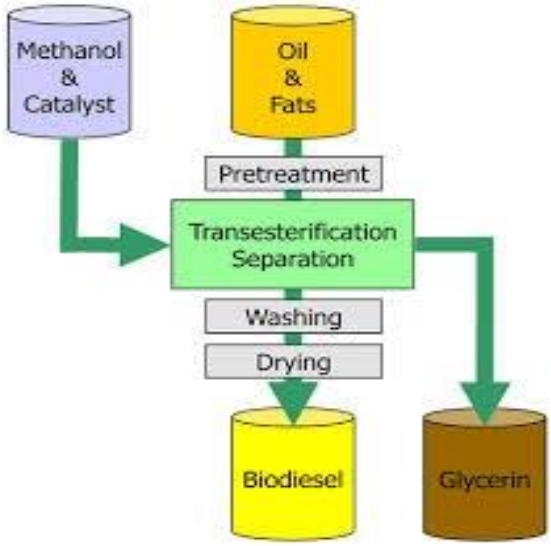
3.2 Oil Extraction:

The ground custard apple seeds are then subjected to a process called solvent extraction, which involves using a solvent, such as hexane or ethanol, to extract the oil from the seeds. The solvent is then removed, leaving behind the custard apple oil.



Transesterification:

The custard apple oil is then subjected to a chemical reaction called transesterification. This involves reacting the oil with an alcohol, such as methanol or ethanol, and a catalyst, such as sodium hydroxide or potassium hydroxide, to produce biodiesel and glycerin.



3.3 Purification:

The resulting biodiesel is then purified to remove any impurities, such as residual catalyst or alcohol, using processes such as washing, drying, or filtration.

3.4 custard apple bio diesel preparation

1. Clean and dry the custard apple seeds to remove any impurities or moisture.
2. Grind the seeds into a fine powder or flakes.
3. Add the ground custard apple seeds to a glass container and cover with a hexane or ethanol solvent. Allow the seeds to soak in the solvent for several hours to extract the oil.
4. Filter the mixture through a filter paper to separate the custard apple oil from the solvent.
5. Add the custard apple oil to a separate glass container.
6. In a separate container, mix methanol or ethanol with a sodium hydroxide or potassium hydroxide catalyst.
7. Add the methanol or ethanol mixture to the custard apple oil and stir vigorously for several hours.
8. Allow the mixture to settle for several hours until the glycerin separates from the biodiesel.
9. Use a separatory funnel to remove the glycerin layer from the biodiesel layer.
10. Wash the biodiesel with water several times to remove any remaining impurities.
11. Allow the biodiesel to dry, either naturally or through heating.
12. Test the quality of the biodiesel by measuring its viscosity, density, flash point, and other important characteristics. The biodiesel must meet certain standards and specifications, such as ASTM D6751, to be considered suitable for use as a fuel.

4. RESULT AND DISCUSSION

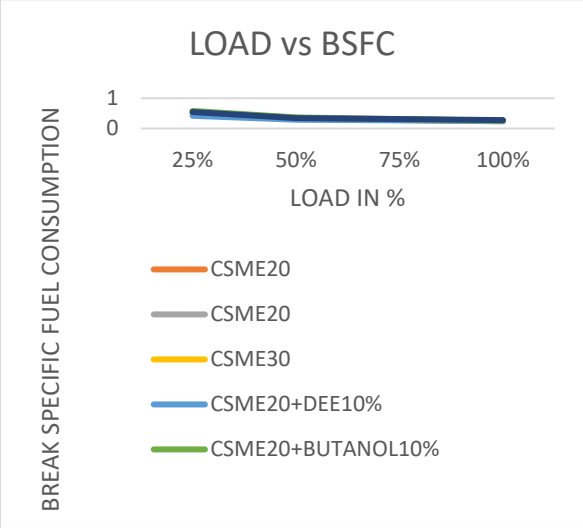
The experimental tests are performed on single cyclinder stationary compression ignition operated at

four loads from 25% to 100% at 25% increments at first diesel engine fueled with diesel and custard biodiesel blend to produce to base information following that experiments are conduct with various fuel additives (Butanol, DEE) custard biodiesl blend. The fuel additives are added to custard biodiesel from the experimentation data of diesel custard biodiesel an fuel additives, the combustion, performance and emission charactersitics of diesel engine are presented and

4.1 Performance analysis

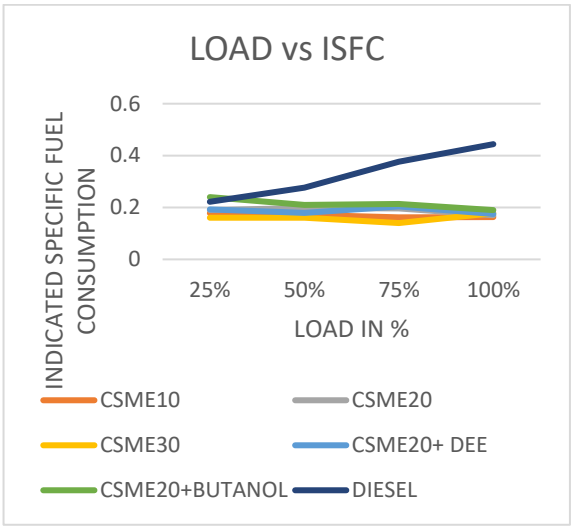
4.1.1 Break- specific fuel consumption

The below graph mentioned that how the brake specific fuel consumption is changing when the load is varying. Here, the graph states that by the variation of load the specific fuel consumption is decreasing. At no load condition to full load conditions the brake specific fuel consumption obtains from CSME10, CSME20, CSME30, CSME20+DEE10%, CSME20+BUTANOL10% and pure diesel are represents. The brake specific fuel consumption of custard oil blend CSME20+DEE10% slightly decreased when compared to other diesel.



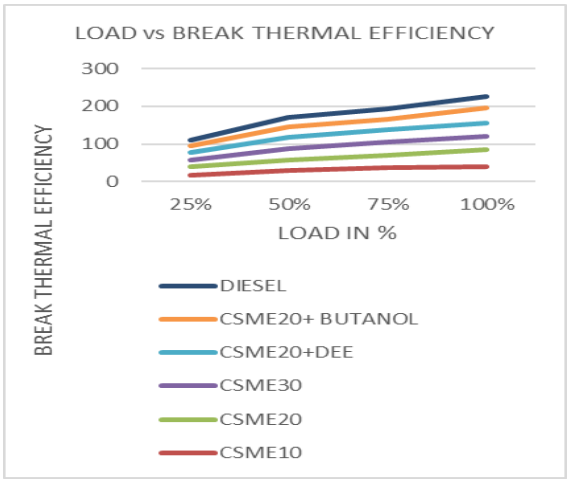
4.1.2 Indicated- specific fuel consumption

The below graph mentioned that how the indicated specific fuel consumption is changing when the load is varying. here the graph states that by the variation of load the specific fuel consumption is decreasing. At no load condition to full load conditions the indicated specific fuel consumption obtains from CSME10, CSME20, CSME30, CSME20+DEE10%, CSME20+BUTANOL10% and pure diesel are represents. The brake specific fuel consumption of custard oil blend CSME20+DEE10% slightly decreased when compared to other diesel.



4.1.3 Break- Thermal Efficiency

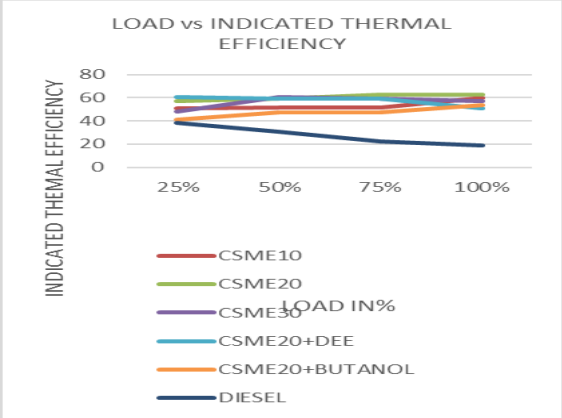
The below graph mentioned that how the break thermal efficiency is changing when the load is varying. here the graph states that the load increases brake thermal efficiency increases. At no load condition to full load conditions the break thermal efficiency obtains from CSME10, CSME20, CSME30,CSME20+DEE10%,CSME20+BUTANOL10% and pure diesel are represents. The brake specific fuel consumption of custard oil blend CSME20+DEE10% slightly decreased when compared to the diesel



4.1.4 Indicated- Thermal Efficiency

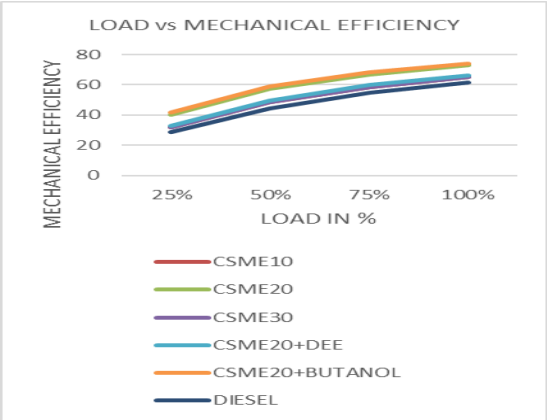
The below graph mentioned that how the Indicated thermal efficiency is changing when the load is varying. Here, the graph states that the load increases indicated thermal efficiency increases At no load

condition to full load conditions the indicated thermal efficiency obtains from CSME10,CSME20,CSME30,CSME20+DEE10%,CSME20+BUTANOL10% and pure diesel are represents. The brake specific fuel consumption of custard oil blend CSME20+DEE10% slightly decreased when compared to the diesel.



4.1.5 Mechanical efficiency

The below graph mentioned that how the Indicated thermal efficiency is changing when the load is varying. Here, the graph states that the load increases mechanical efficiency increases At no load condition to full load conditions the mechanical efficiency obtains from CSME10, CSME20,CSME30,CSME20+DEE10%,CSME20+BUTANOL10% and pure diesel are represents. The brake specific fuel consumption of custard oil blend CSME20+DEE10% slightly decreased when compared to the diesel.

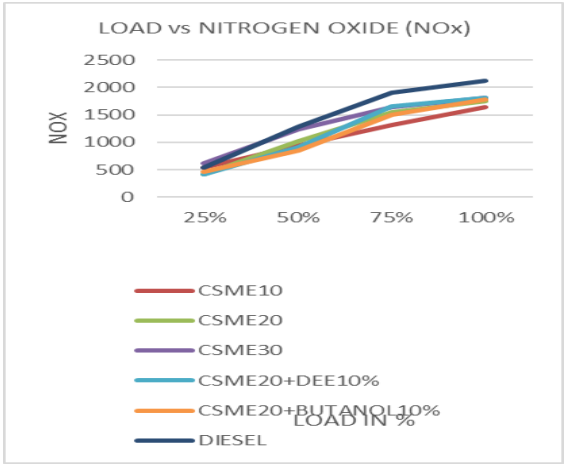


4.2 Emission Analysis

4.2.1Nitrogen oxide (NO_X)

Nitrogen oxide development fundamentally relies upon the availability of oxygen and higher temperature while combustion of air/fuel mixture in the combustion chamber. NOx emissions are formed by Zeldovich mechanism of reactions between O2 and N2molecules. oxide for the used fuel samples in this investigation at different loads. The oxides of nitrogen emissions of tested fuel samples of diesel,

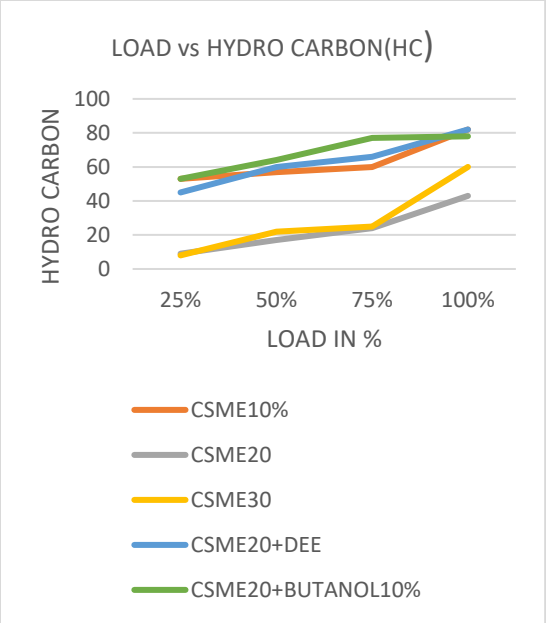
The below graph mentioned that how Nitrogen oxide(NO_X) is changing when the load is varying. Here, the graph states that the load increases Nitrogen oxide decreasing. At no load condition to full load conditions the nitrogen oxide obtains fromCSME10,CSME20,CSME30,CSME20+DEE10%,CSME20+BUTANOL10% and pure diesel are represents. The brake specific fuel consumption of custard oil blend CSME20+DEE10% slightly decreased when compared to the diesel.



4.2.2 Hydrocarbon oxide

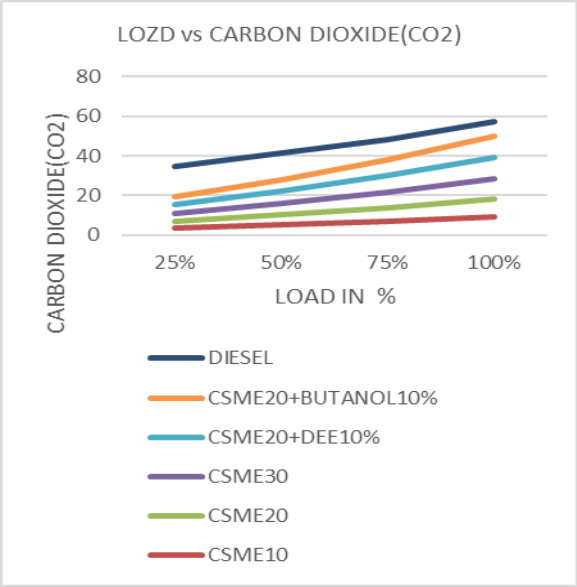
Hydro carbon emissions are generated owing to incomplete burning phenomenon and its sources in the engines are nozzle which get released during exhaust stroke as unburnt hydrocarbon emissions

The below graph mentioned that how hydrocarbon oxide is changing when the load is varying. Here, the graph states that the load increases hydrocarbon oxide decreasing. At no load condition to full load conditions the hydrocarbon oxide obtains from CSME10,CSME20,CSME30, CSME20+DEE10%, CSME20+BUTANOL10% and pure diesel are represents. The brake specific fuel consumption of custard oil blend CSME20+DEE10% slightly decreased when compared to the diesel.`



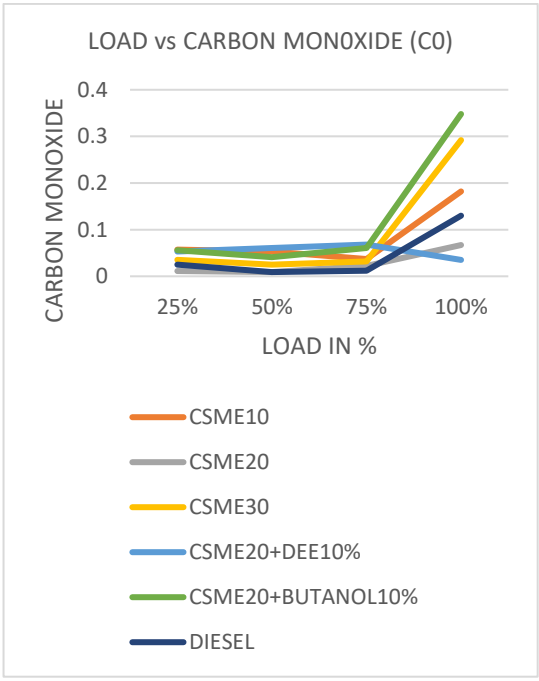
4.2.3 Carbon dioxide

The below graph mentioned that how carbon dioxide is changing when the load is varying. Here, the graph states that the load increases carbon dioxide decreasing. At no load condition to full load conditions the carbon dioxide obtains from CSME10, CSME20, CSME30, CSME20 +DEE10% ,CSME20+BUTANOL10% and pure diesel are represents. The brake specific fuel consumption of custard oil blend CSME20+DEE10% slightly decreased when compared to the diesel.`



4.2.4 carbon monoxide (co)

The below graph mentioned that how carbon monoxide is changing when the load is varying. Here, the graph states that the load increases carbon monoxide decreasing. At no load condition to full load conditions the carbon monoxide obtains fromCSME10, CSME20, CSME30, CSME20 +DEE10%, CSME20+BUTANOL10% and pure diesel are represents. The brake specific fuel consumption of custard oil blend CSME20 +DEE10% slightly decreased when compared to the diesel.



5. CONCLUSION

- The physical and chemical properties of custard seed oil was experimentally evaluated and observed that it has higher viscosity and density which will result in low volatility and poor atomization of oil during oil injection in combustion chamber causing incomplete combustion and carbon deposits in combustion chamber.
- For these reasons crude custard seed oil is converted to custard seed methyl ester by Transesterification process. Transesterification process is a method to reduce viscosity of custard seed oil with low production cost.
- It is observed that among the tested biodiesel blends of custard seed methyl ester, CSME20 produced better performance, combustion and emission

characteristics compared to CSME10 and CSME30, So CSME20 is taken as optimum blend.

- The brake thermal efficiency increases with increase in ignition improver by volume percentage in blends. From the results of biodiesel blends with added ignition improver, CSME20+10% Die ethyl ether and SSME20+10%butanol showed better result with improvement of brake thermal efficiency about 3.15% than that of CSME20.
- Results obtained in this work show that biodiesel is obtained from custard seed oil has properties close to diesel. Therefore, it can be used as a substitute for diesel oil. Oil has the advantage that it is a non-polluting source of energy, hence, it can help in reducing the emission of greenhouse gases and other emissions that are toxic and cacogenic.
- So in the future B20 is one of the working fuels in diesel engines in order to improve efficiency and 30% of diesel is saved by using it as a fuel.

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